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(54) SMART CARD ACCESS CONTROL SYSTEM

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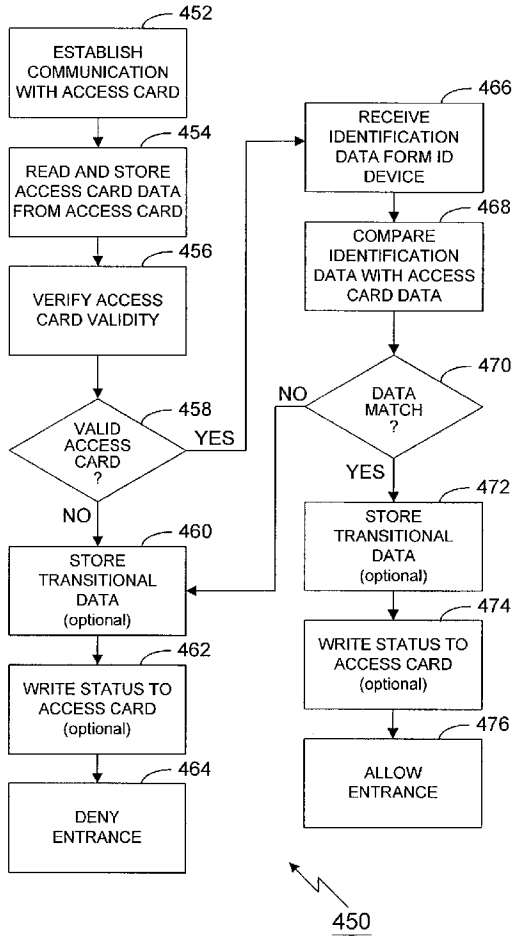
(52) **U.S. Cl.** **713/202**; 382/115

(57) **ABSTRACT**

An access control system securely transfers identification and transaction information between an access reader and a contactless smart card over a contactless radio frequency link via an RF modem. The access reader contains a programmable microcontroller, DC/DC converter, regulator, Opto-Isolators and LEDS, and an RF modem. The smart cards contain identification or transaction data as well as reader programming and de-programming software, which is protected by appropriate security keys. An access reader having the appropriate security keys performs a one to one verification of data stored in the smart card to data from an identification device coupled to the access reader. Upon verification of the validity of the smart card, the access reader transfers identification and transaction information over a data link to any external processor or controller which controls access to a secured area. Both the data format/protocol and operating state out of the access reader is programmable and configurable at any time. The access reader and access cards are compatible with any existing Wiegand, magnetic stripe, and serial based access control systems, and are configurable to emerging Biometric system designs.



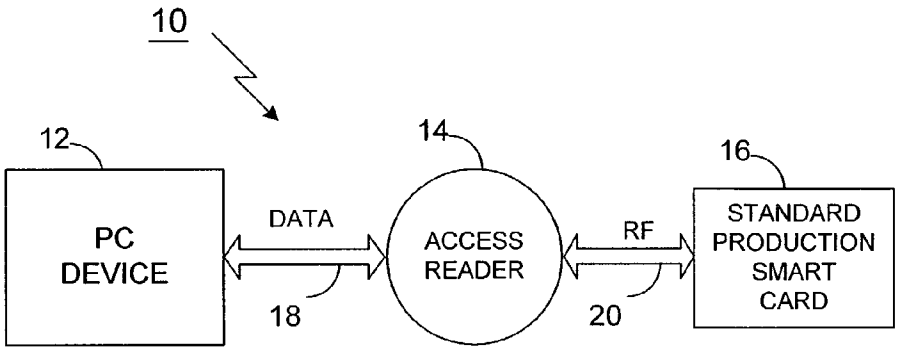

10
12
PC DEVICE
DATA
18
14
ACCESS READER
RF
20
16
STANDARD PRODUCTION SMART CARD

FIG. 1

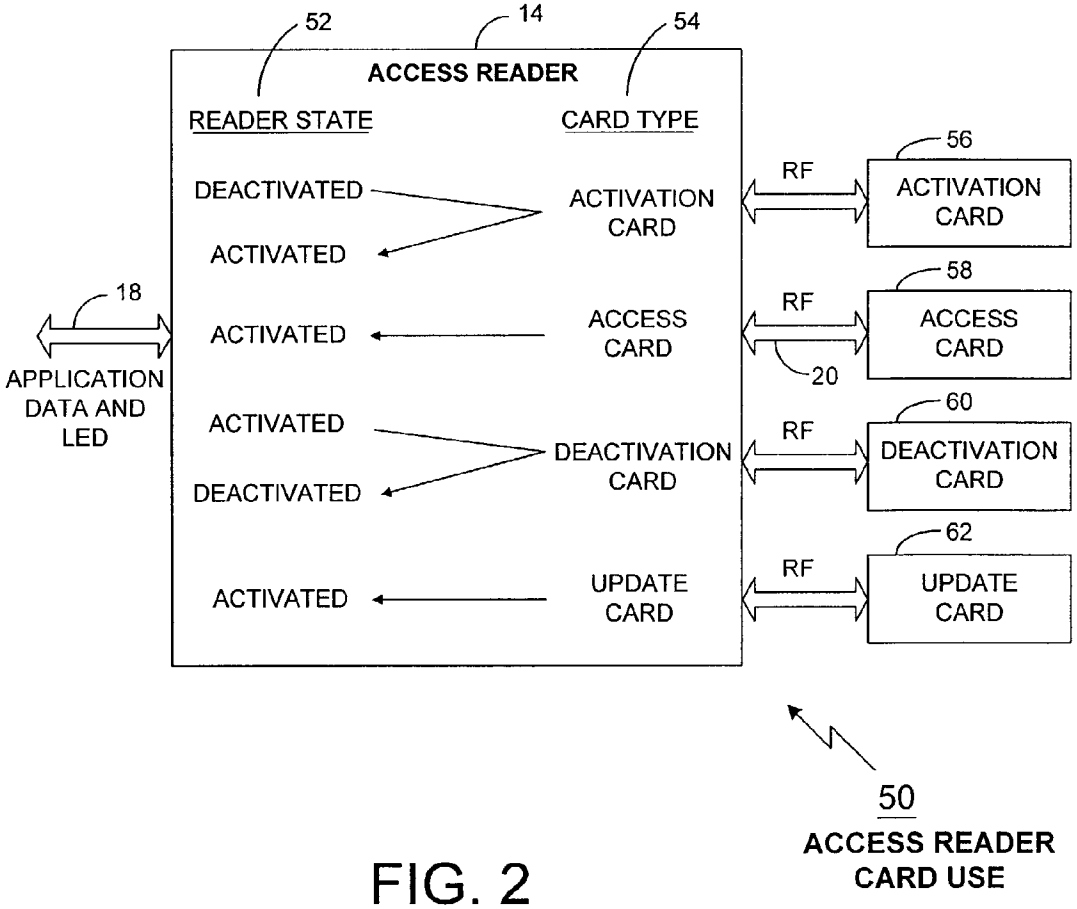

52
14
54
ACCESS READER
READER STATE
CARD TYPE
DEACTIVATED
ACTIVATED
ACTIVATION CARD
ACTIVATED
ACCESS CARD
ACTIVATED
DEACTIVATED
DEACTIVATION CARD
ACTIVATED
UPDATE CARD
18
APPLICATION DATA AND LED
RF
56
ACTIVATION CARD
RF
58
ACCESS CARD
20
RF
60
DEACTIVATION CARD
RF
62
UPDATE CARD
50
ACCESS READER CARD USE

FIG. 2

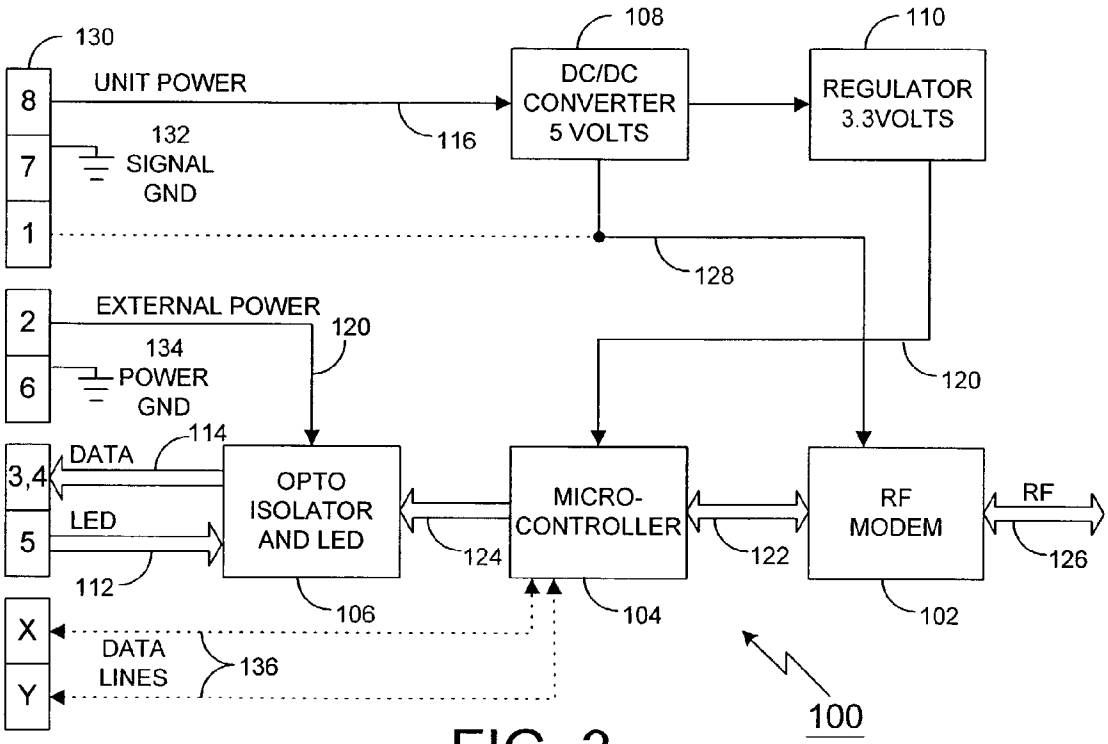

130
8
7
1
UNIT POWER
132
SIGNAL GND
116
108
DC/DC CONVERTER 5 VOLTS
110
REGULATOR 3.3VOLTS
128
2
6
EXTERNAL POWER
120
134
POWER GND
120
114
3,4
DATA
5
LED
112
OPTO ISOLATOR AND LED
106
MICRO-CONTROLLER
104
124
122
RF MODEM
102
RF
126
X
Y
DATA LINES
136
100

FIG. 3

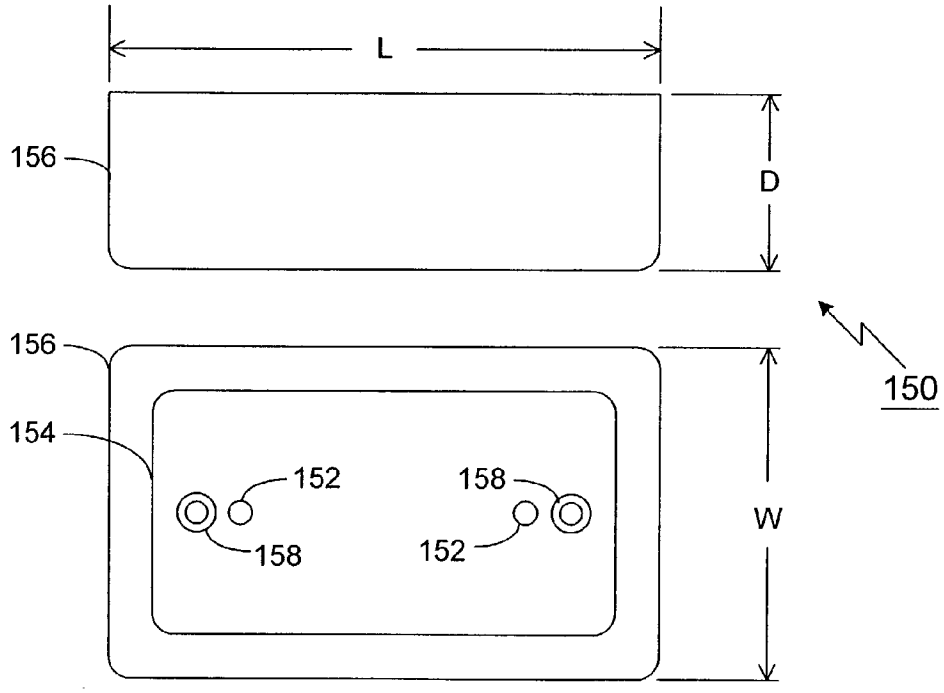

L
156
D
156
154
152
158
158
152
W
150

FIG. 4

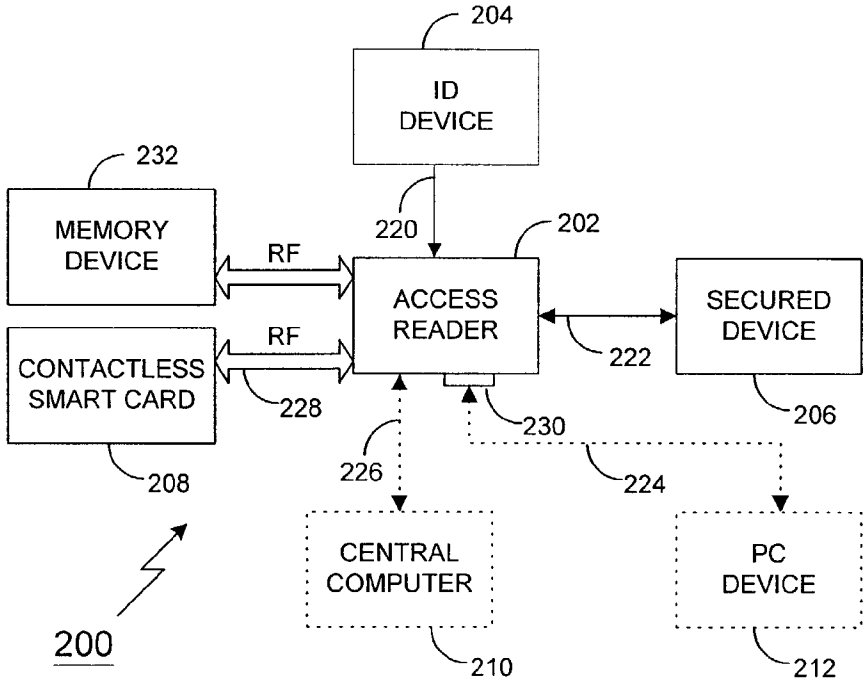

204
ID DEVICE
232
MEMORY DEVICE
RF
220
202
ACCESS READER
SECURED DEVICE
222
RF
CONTACTLESS SMART CARD
228
206
230
208
226
224
CENTRAL COMPUTER
PC DEVICE
200
210
212

FIG. 5

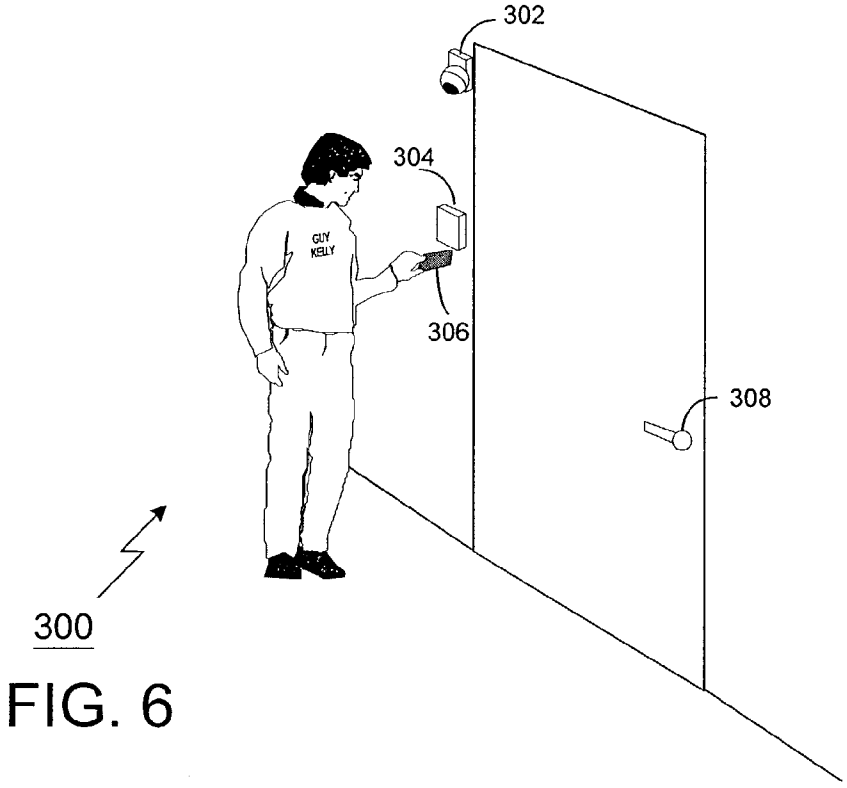

302
304
306
308
300

FIG. 6

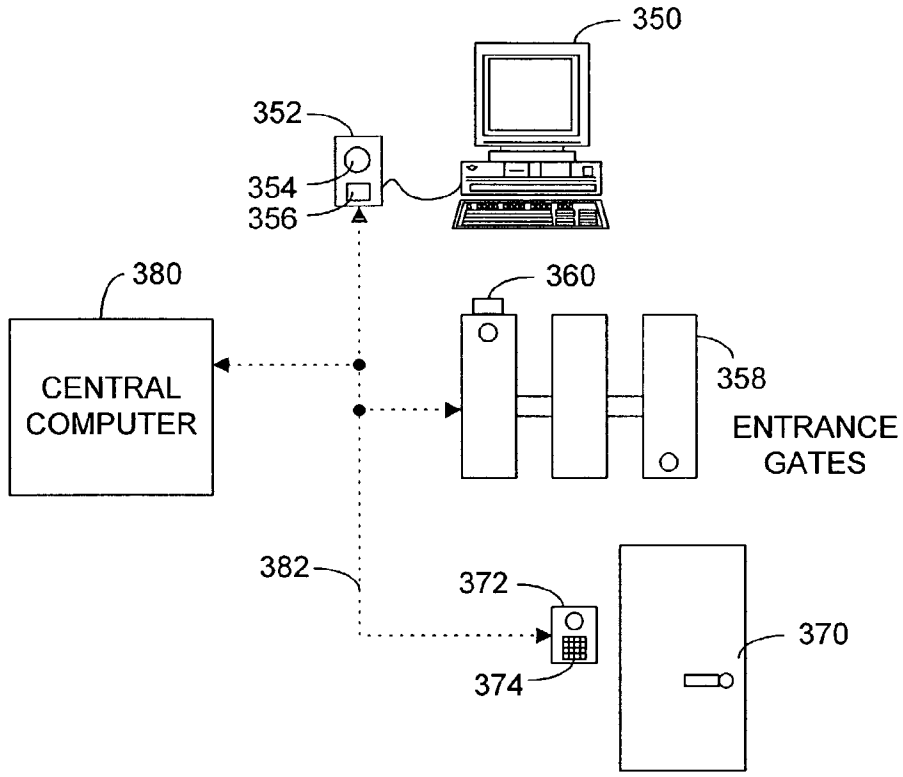

350
352
354
356
380
CENTRAL COMPUTER
360
358
ENTRANCE GATES
382
372
374
370

FIG. 7

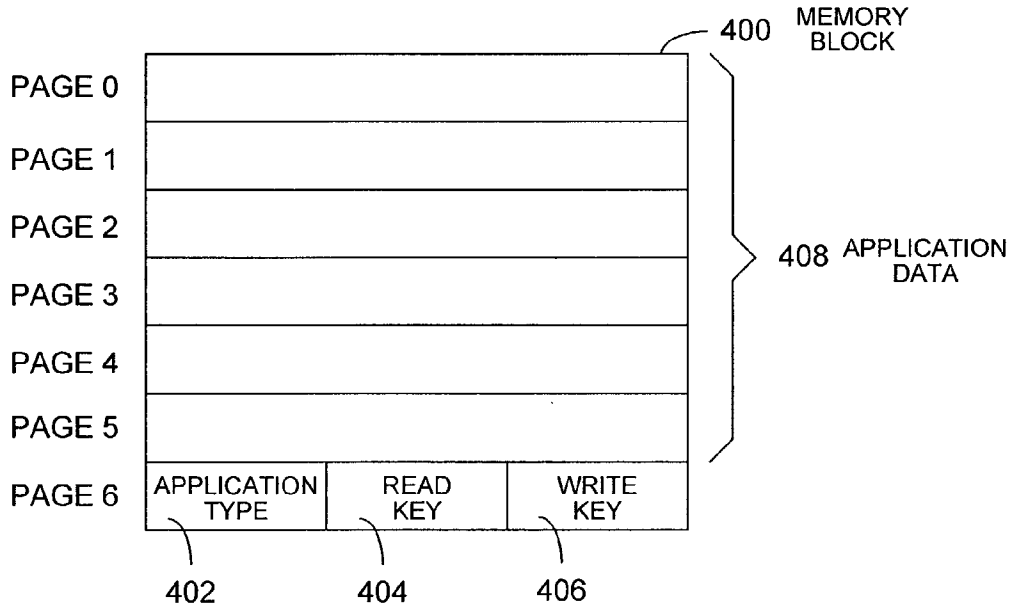

400
MEMORY BLOCK
PAGE 0
PAGE 1
PAGE 2
PAGE 3
PAGE 4
PAGE 5
PAGE 6
408
APPLICATION DATA
APPLICATION TYPE
READ KEY
WRITE KEY
402
404
406

FIG. 8

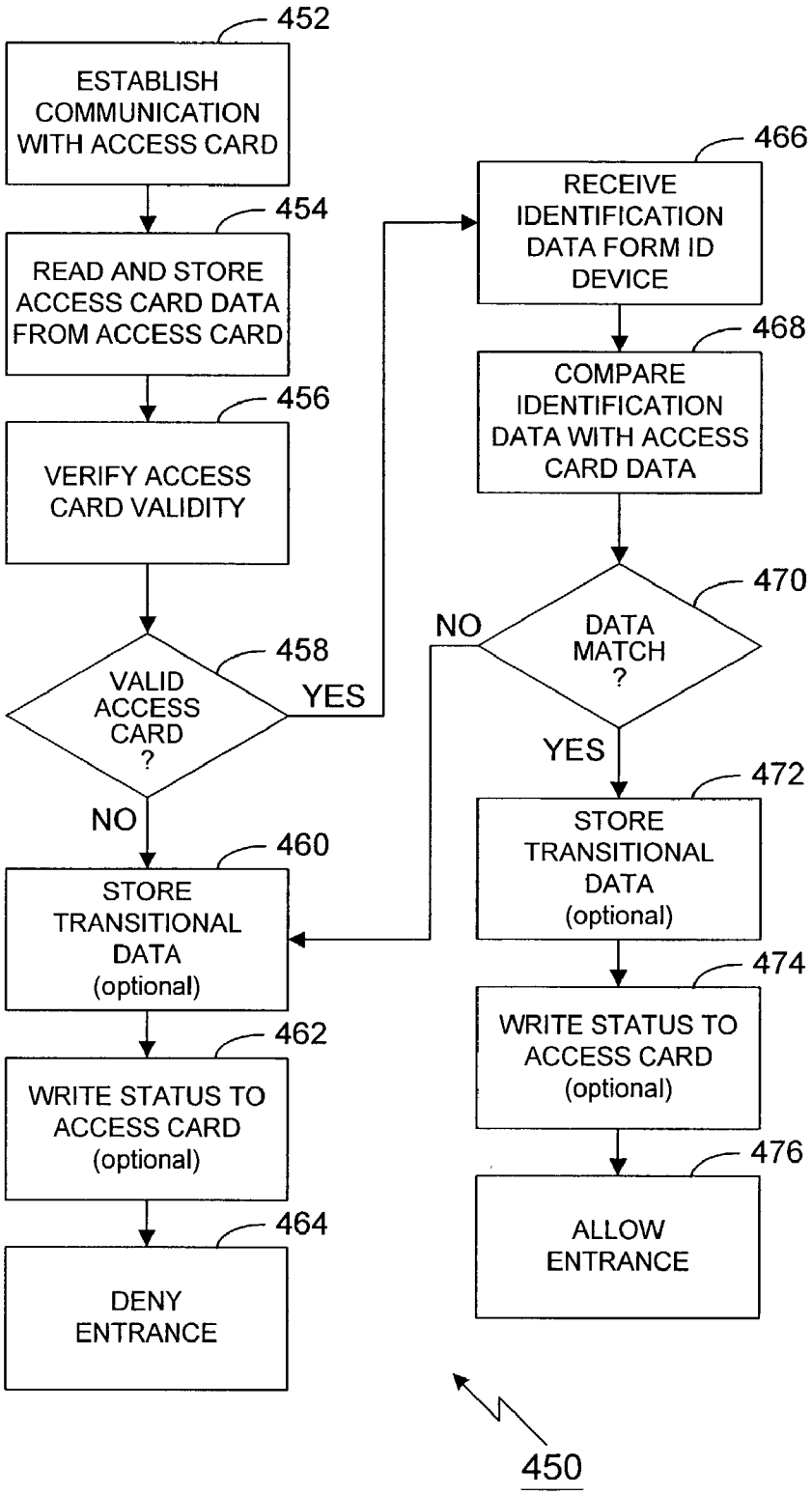

452
ESTABLISH COMMUNICATION WITH ACCESS CARD
454
READ AND STORE ACCESS CARD DATA FROM ACCESS CARD
456
VERIFY ACCESS CARD VALIDITY
458
VALID ACCESS CARD ?
YES
NO
460
STORE TRANSITIONAL DATA (optional)
462
WRITE STATUS TO ACCESS CARD (optional)
464
DENY ENTRANCE
466
RECEIVE IDENTIFICATION DATA FORM ID DEVICE
468
COMPARE IDENTIFICATION DATA WITH ACCESS CARD DATA
470
DATA MATCH ?
NO
YES
472
STORE TRANSITIONAL DATA (optional)
474
WRITE STATUS TO ACCESS CARD (optional)
476
ALLOW ENTRANCE
450

FIG. 9

SMART CARD ACCESS CONTROL SYSTEM

CROSS-REFERENCES TO RELATED APPLICATIONS

[0001] This application claims the benefit of priority under 35 U.S.C. 119(e) to Provisional U.S. Patent Application No. 60/289,039 filed May 4, 2001 and Provisional U.S. Patent Application No. 60/318,385 filed September 10, 2001 which are incorporated herein by reference in their entirety.

BACKGROUND OF THE INVENTION

[0002] 1. Field of Invention

[0003] This invention relates generally to access systems for accessing restricted areas, and more specifically to a one to one comparison access card reader utilizing security keys for true authenticated verification of the identity of an access card holder attempting to gain access to a restricted area.

[0004] 2. Background

[0005] Access readers typically are small boxes located proximate to the entrances to restricted, or secured, areas. To gain access to an area, an access card holder must present an access card to the access reader, which in turn verifies the information on the card with a central computer. Commonly used access cards include both contact and contactless smart cards. In the prior art systems, the central computer stores data files associated with each access card holder, including information regarding employee identification, card validity, and access rules. The verification process of the prior art requires an initial communication between the access card and the access card reader, communication between the access reader and the central computer, verification of card holder data and access card data at the central computer, communication of the results from the central computer to the access reader, and communication of the results to the access card holder by allowing or denying access to the restricted area.

[0006] The verification process of the prior art is sufficient for low traffic entrances, such as a gated entrances for a small office building, wherein the additional time required for the verification process does not cause long queues of employees waiting to pass through the gate. However, even a slight delay required to swipe a contact card and to verify card holder data at the central computer may be inconvenient for "high traffic" entrance ways. Further, complex comparisons such as biometric identification, requires a complex decision process and associated software that must be performed by the central computer as the currently available access readers and access cards have limited storage capacity and processing capability. In addition, the central computer must have updated information for each person, including infrequent visitors, who have clearance to enter a secured area. The data bases stored at the central computer for these entrance ways have the potential to be unmanageable, particularly for multi-story, multi-company office buildings. Security necessarily is augmented through use of security personnel stationed at the gates to check and/or verify identification of employees as they enter the gates.

[0007] Installations of the prior art access control systems are costly. Each new access gate or entrance way requires installation of communication lines to the central computer. For multi-story or expansive buildings, the wiring and/or re-wiring process is both time-consuming and expensive. These factors often present cost-prohibitive blocks to converting rooms, labs, or designated areas into secured access areas. In addition, because each door or gate may have different access rights, the central computer also must keep track of personnel access rights for every door or gate. Installation of a new gated entrance requires update of the central computer data bases. In addition, each change in personnel or a change in personnel access to restricted areas requires an update to the data bases, and for large companies, the changes may be required daily.

[0008] The prior art also presents security issues. For example, an access card holder user can enter a secured area with an unreported stolen card if the verification process is for validity of the card, only. Thus, for security purposes, entrance ways are often manned to verify the identity of a person holding the card with a picture identification on the access card. One way to eliminate the requirement of security personnel at each entrance way, is through the use of automatic identification systems connected to the central computer. Biometric systems such as fingerprint identification systems are becoming increasingly popular as the biometric technology develops to further identify an access card holder as he or she passes through the secured entrance way. Although the biometric systems may add security of verification and eliminate additional security personnel, the central computer is further burdened with storage of the biometric information. Biometric systems typically employ the concept of a "one to many" comparison, that is, an access card holder presents his fingertip for fingerprint imaging, and this one image is transmitted to a central computer for comparison to many fingerprints to find a matching print. The comparison and search time further slows down the identification process to add delays to the time required to pass through a secure entrance way.

[0009] Therefore, a need remains for an access control system that does not require connection to a central computer, but which provides verification of the validity of the access card as well as identification of the access card holder. A further need remains for access readers and access cards that have expanded storage and processing capability for performing complex decision processes and comparisons, such as biometric identification. Yet a further need remains for an access control system which minimizes installation time and cost, which is compatible with existing access control systems, and which may be updated to accommodate changes in secure area entrance rules and locations.

SUMMARY OF THE INVENTION

[0010] It is an advantage of the present invention to provide an access control system that does not require communication to a central computer for activation, access card verification, and reconfiguration.

[0011] It is another advantage to provide an access control system which employs a one to one verification process at the access card reader and does not require data storage for every access card holder.

[0012] Still another advantage is to provide an access control system that may be configured to emulate a variety of access cards to allow compatibility with existing access systems.

[0013] It is yet another advantage to provide an access control system which may be configured to allow different access rights to a variety of gated entrances.

[0014] A further advantage is to provide an access control system having the option for an unattended or attended secured entrance way.

[0015] In an exemplary embodiment of the present invention an access control system includes a access reader having an RF interface for communication with a contactless smart card, at least one serial connection to an identification (ID) device, and data output lines for controlling access to a secured entrance. The contactless smart card includes memory divided into a number of blocks, wherein each block is further divided into pages of a predetermined number of bytes. At least one page of each block is utilized to store an application type number key, a read key, and a write key. The access reader communicates with the smart card providing the access reader is supplied with the keys of at least one memory bock of the smart card. The use of keys provides an authenticated read of data from the access card that is not provided in prior art access control systems.

[0016] The access control system of the exemplary embodiment of the present invention utilizes four types of contactless smart cards including activation cards, access cards, deactivation cards, and update cards. In an exemplary embodiment of the invention, the access readers are pre-programmed during manufacture with an initial activation key. The access readers may then be initialized by reading data from an activation card encoded with the same key. The deactivation card returns the access reader to a production state awaiting an activation card. Modifications in access reader data, such as keys, are downloaded to the access reader utilizing an update card. In one embodiment of the invention, the access reader includes a serial port for connection with a personal computer (PC) device. The PC device may be used for initializing or updating the access reader, or for collecting transaction, or "log" , data from the access reader.

[0017] Access cards are presented to the access readers to gain entrance to secured areas. The access cards are further formatted to contain application specific data in a designated memory blocks. Each memory block has an application type number key, a read key, and a write key. The application specific data is the data required by the access reader to verify the identity of the access card holder against data received from an identification device. Identification devices of the exemplary embodiment, such as keypads and biometric identification devices, may vary according to the use of the access reader. The access reader includes a microprocessor for comparing the application specific data from the access card with the data received from the identification device. Upon verification of a match of the data, the access reader permits the access card holder to enter the secured area.

[0018] The access reader of an exemplary embodiment of the present invention receives identification data from biometric devices for comparison to identification data contained on the access cards. The biometric devices provide biometric images, e.g., fingerprint images, retinal images, and/or facial images, as well as template minutia of the actual images. The template minutia may be used by an access reader for automatic comparison of the template minutia from the biometric device with the template minutia stored on an access card. The actual images from the access card and the biometric device may be used by security personnel to make decisions whether to permit an access card holder access to the secured area. Thus, the access control system of the exemplary embodiment provides means for both attended and unattended identification verification.

[0019] The access reader of the exemplary embodiment may be integrated with existing access control systems by programming the access reader to output a data stream required by the existing system upon verification of the identification data from an ID device with the application data from the access card. For example, access control systems that utilize key pads and swipe cards, and which output Wiegand bit streams, may be updated by providing access readers that output the same Wiegand bit streams upon a positive comparison of the key pad entries to the entries stored on the contactless access card. The access reader may be configured to be compatible with other existing access readers, such as magnetic stripe and serial based access control systems in the same manner. The ability to integrate the access reader of the exemplary embodiment with existing systems, enables the existing system to be updated for contactless smart card operation without a shut down of the exiting system.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] The present invention will be better understood from the following detailed description of a preferred embodiment of the invention, taken in conjunction with the accompanying drawings in which like reference numerals refer to like parts and in which:

[0021] **FIG. 1** is an illustration of the initialization components for a smart card access control system of a preferred embodiment;

[0022] **FIG. 2** is a block diagram of the access reader states and card types of the preferred embodiment;

[0023] **FIG. 3** is an illustration of the components of an access reader of a first embodiment of the present invention;

[0024] **FIG. 4** is an illustration of a preferred physical configuration of an access reader;

[0025] **FIG. 5** is an illustration of an access control system of a preferred embodiment;

[0026] **FIG. 6** is an illustration of a biometric access control system of a preferred embodiment;

[0027] **FIG. 7** is an illustration of example equipment that may employ the use of the access control system of a preferred embodiment of the present invention;

[0028] **FIG. 8** is an illustration of a memory block of a contactless smart card of the preferred embodiment; and

[0029] **FIG. 9** is a flow diagram of a method of the preferred embodiment for an access control system.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0030] **FIG. 5** illustrates the smart card access control system **200** of a preferred embodiment of the present invention. The system **200** includes an access control unit (ACU), also referred to as an access reader **202**, which communicates by radio frequency **228** to an access card, e.g., a contactless smart card **208**. The access reader may be used for basic applications such as transit access, loyalty transactions, and health care benefits which utilizes a contactless

smart card. However, this basic system has minimum use as the access reader **202** is limited to verifying the validity of the smart card **208** rather than further identifying the access card holder. Thus, the access control system **200** of the preferred embodiment further includes an identification device **204**, such as a keypad or a biometric device. A biometric device includes, e.g., a camera and processor for facial or retinal recognition, or a fingerprint pad and processor for fingerprint identification. In other embodiments of the invention, the identification device **204** can be incorporated into the access reader **202**. The output data **220** from the identification device **204** is sent to the access reader **220** which performs a one-to-one (1:1) comparison of the output data **220** with card data read from the access card **208**. A positive verification may be indicated by the illumination of an indicator and/or by the output of a control signal **222** to a secured device **206** such as a door lock or a gate turnstile.

[**0031**] Continuing with **FIG. 5**, the access reader **202** of a preferred embodiment may include a serial port **230** for connection with a personal computer-type (PC) device **212**. The PC device **212** may be utilized with the access reader **202** to program standard production smart cards **208**. The programmed smart cards **208**, then are utilized to program an access reader **202** for a desired mode of operation. The PC device **212**, or a contactless update card **62**, as shown in **FIG. 2**, may be used to download database material to the access reader **202**. Similarly, the PC device **212** or a contactless memory device **232** may be utilized to upload log lists from the access reader **202**. Log lists may include data collected from access cards **208** that are presented to the access reader **202**, as well as data identifying the access reader **230**. The access reader **202** of the preferred embodiment is connected via another serial connection **226** to a central computer **210**. The access reader **202** performs the access identification process in real time, and uploads the results of the "transactions" to the central computer at a later time, for example, each night after a business day.

[**0032**] **FIG. 3** illustrates the electrical hardware components of an access reader **100** of a preferred embodiment of the present invention. The access reader **100** includes a microcontroller **104** for performing the access verification processes, and an RF modem **102** for communicating with a contactless smart card. Unit power **116** is connected to a DC to DC converter **108** which supplies 5 volts internal power **128** to the RF modem **102**. The DC to DC converter **108** is connected to a regulator **110** which supplies power **120** to the microcontroller **104**. The RF modem **102** of the preferred embodiment generates a 13.56 MHZ RF field **126**, and reads standard smart cards at distances up to 10 cm. The microcontroller **104** outputs data signals **124** for controlling the secured device **206**, as shown in **FIG. 5**, for illuminating an indicator, such as an LED **112**, or for communicating with the central computer **210** or the PC device **212**. The microcontroller **104** includes memory for storing data such as software applications for validation processes, and negative lists of invalid access cards. Additional input data lines **136** may be required to communicate with multiple identification devices **204** or with an existing access control system reader.

[**0033**] Continuing with **FIG. 3**, in one embodiment of the present invention, the access reader **100** includes an optoisolater **106** for isolating the microcontroller **104** from the unit power **116** and the internal power **118**. A terminal block **130** of the preferred embodiment utilizes at least eight connections as shown in Table 1. Additional connectors/terminals X, Y, etc. may be necessary for data communications to existing devices (not shown) and external devices **204**, **206**, **212**, **210**, as shown in **FIG. 5**. If the microcontroller **104** does not require optical isolation, the unit power **116** and the external power **120** may be provided from the same power source by connecting terminals **2** and **8**, and by connecting terminals **6** and **7**, for the terminal block **130** configuration shown in **FIG. 3**. This configuration uses the external power **120** for the optical isolator and the LED **106**, but defeats the optical isolation by connecting the signal ground **132** to the power ground **134**.

[**0034**] As shown in Table 1 for one embodiment of the access reader **100**, terminals 3 and 4 are data outputs. Other embodiments of the invention may require more or fewer data outputs. For example, if the access reader **100** is programmed by activation card to output Wiegand data, the data appears on terminals 3 and 4. If the unit is programmed to output serial or magnetic-stripe data the data appears on pin 3, only.

TABLE 1

Terminal Block Connections for an Access Reader

Terminal	Function	Comment
1	Internal 5 Volts; or Test Terminal	Provides +5 Volts at up to 100 mA; or for production testing
2	External 5 to 28 Volts	Isolator and LED power (Requires +5 to +28 Volts at 20 mA)
3	Data 1	Optically isolated data out
4	Data 0	Optically isolated data out
5	LED	High = Red, low = Green, unconnected = Yellow
6	External Common	Isolator and LED power and data signal common
7	Power Common	Unit power and internal +5 Volt common
8	Unit Power	Requires from +8 to +28 Volts at up to 2.5 Watts

[**0035**] **FIG. 4** illustrates a packaging configuration **150** for the electrical components of the access reader **100** of **FIG. 3**. The packaged access reader **150** of a preferred embodiment of the invention utilizes the same area footprint as a single-gang wall plate having a width, W, of 2.75 inches (6.98 cm) and a length, L, of 4.5 inches (11.43 cm). The packaged access reader **150** is mounted onto a surface using two mounting holes **158** that match the holes in a single-gang electrical utility box. Another embodiment of the packaged access reader **150** replaces or fits inside the electrical utility box. The packaged access reader **150** of the preferred embodiment has a depth, D, of 1.5 inches (3.81 cm), be configured for any necessary thickness. The packaged access reader **150** has a faceplate area **154** which provides a target for the presentation of an access card. At least one LED **152** on the faceplate **154** illuminates to red to signal an invalid card or a read error. A valid card and a successful identification of the access card holder is indicated by the LED **152** illuminating to green. The LED **152** provides the access card holder with an indication that the access reader **100** is operational. In other embodiments, the packaging configuration be of any form factor desired by a customer.

[**0036**] **FIG. 6** illustrates a biometric configuration **300** of one embodiment of the invention. The access card reader **304** is installed adjacent a door and controls the door reader **308**. An access card holder presents his access card **306** to the access card reader **304**, which reads pre-stored access data from the access card **306**. In this configuration **300**, a camera **302** sends an image and/or image minutia of the

access card holder to the access card reader **304**. The access card reader **304** compares the data from the camera **302** with the pre-stored access data on the access card **306** to verify identification of the access card holder. If the image data matches the pre-stored access data, then the identification of the access card holder may be guaranteed to a higher degree than existing control systems that verify one data component, only. This validation is a one to one comparison, and does not require communication with a data base of a central computer.

[**0037**] To prevent security breaches, the access card reader **304** of the preferred embodiment performs additional verifications before or after the identification process. For example, the access card reader **304** must first establish communication with the access card **306** utilizing specific protocols. The communication protocols may also identify particular information about the access card **306**, such as the serial number of the access card **306**. If the access card **306** does not respond to the required communication protocols transmitted by the access reader **304**, then the access card **306** is not valid for that particular entrance way **308**. Once communication is established between the access card **306** and the access reader **304**, the access reader **304** can read data from the access card **306** only if it knows at least one application key and read key stored on the access card **306**. In an alternate embodiment, the access card reader **304** further compares the access card information, such as the serial number, with access card holder data, such as negative lists, that are downloaded to the access reader **304** at regular intervals by means of the PC Device **212**, the central computer **210**, or an update card **62** as illustrated in **FIG. 5**. If any of the validation processes have a negative result, the access card reader **304** denies access to the secured area.

[**0038**] In an alternate embodiment of the invention, the access card reader **304** may also write an invalidation code to the access card **306** providing the access card reader **304** has a correct write key. The invalidation code on the smart card may be recognized by all or specific access readers. Access readers that recognize the invalidation code may then deny access to corresponding secured areas until the access card **306** is re-validated by security personnel.

[**0039**] For additional security, it is possible to require the access card holder to present the access card **306** before exiting the same, or another, entrance. Because the identification of the access card holder and the validity of the access card **306** is determined by the access card reader **304** immediately upon presentation of the access card **306**, the access card holder may gain entrance into a secured area using an access card **306** that is invalid. However, a further validation may be performed for access card readers **202** that are connected to a central computer **210**, as shown in **FIG. 5**. The transaction log data, including, for example, the access card serial number and time of entrance is uploaded to the central computer **210** or a memory device **232** at regular intervals and/or after a pre-determined number of identification verifications. The central computer performs a validity check of the transaction data for each access card **208** against data stored in the central computer. If the card is determined to be invalid, the central computer **210** then downloads updated information to the access readers **202** of the secured area to deny exit for the access card holder, and alerts security. The preferred embodiment of the access reader **202** also includes an additional security measure for notifying security personnel of an attempted removal of the access reader **202**. For example, upon the detection of a loss of power, the access reader **202** sends an identifying signal to the central computer **210**.

[**0040**] **FIG. 1** illustrates the initialization components **10** for the smart card access control system of a preferred embodiment. The components **10** include an access reader **14**, a standard production smart card **16**, and a personal computer device **12**. The access reader **14** includes a serial port for data communication **18** between the access reader **14** and the PC device **12**, e.g., a laptop or hand held computer device. In an alternate embodiment of the invention, a central computer, as shown in **FIG. 5**, that is hardwired to the access reader **14** may perform the installation and configuration processes of the PC device **12**. Continuing with **FIG. 1**, the PC device **12** together with the access reader **14** are utilized to create various card types **54** from standard production smart cards **16**. **FIG. 2** illustrates the access reader states **52** and card types **54** of the preferred embodiment. The different card types **54** are used with the access reader **14** for activation, access, deactivation, and update purposes.

[**0041**] Continuing with **FIG. 2**, the access reader **14** has two operational reader states **52** which are the deactivated operational state and the activated operational state. Upon power-up, the access reader **14** of the preferred embodiment indicates its operational state by, for example, beeping three times to indicate that it is in the deactivated operational state. In the deactivated operational state, the access reader **14** waits for an activation card **56** to lock it into the activated state. When a valid activation card **56** is presented to the access reader **14**, the access reader **14** is locked into the activated operational state using the application type number, the read key, and output format specified by the activation card **56**. If a production smart card **16** is presented to the access reader **14** while the reader is in the deactivated operational state **52**, and the smart card is not a valid activation card **56**, the access reader **14** will signal an error condition, e.g., two beeps.

[**0042**] The activated operational state of the access reader **14** utilizes customer specific application type keys which are pre-loaded into the access reader **14**. Upon power-up, the access reader **14** of the preferred embodiment indicates that it is in an activated operational state by, for example, beeping once for a duration of one second. Table 2 lists the actions that an access reader **14** of the preferred embodiment takes upon presentation/detection of an access card **16**. In the activated operational state, the access reader **14** only reads access cards **58** that are encoded by a customer with an appropriate read key in order to prevent unauthorized cards from communicating data to the access reader **14** In the preferred embodiment, the read key of the access card **58** is encrypted to produce a hash key. The access reader **14** reads the hash key and uses the encryption code to determine whether the read key of the access card **58** is valid. The use of the read/hash key provides an authenticated security which is not found in current access systems. Other systems which provide un-authenticated Wiegand identification numbers can easily be replicated via playback attack.

[**0043**] As shown in Table 2, if the read key is invalid, the access reader **14** beeps twice to indicate the invalidity of the access card **58** and no data is output to control access to the

secured area. In the preferred embodiment, the serial card number or any other identifying data of the invalid access card **58**, if available, is stored in a log file in the access reader for subsequent uploading to a PC device **212**, a central computer **212**, or contactless memory device **232**. The information them may be utilized to perform actions such as alerting security or placing the access card **212** on a negative list. If the read key stored in the access reader **14** is correct, the access reader **14** can attempt to read data from the access card **58**. If data is not available, the access reader **14** signals access card **58** invalidity by beeping twice. If data is available, the access reader **14** performs a cyclic redundancy check (CRC) on the data to determine whether parity is correct. If all three conditions are met, then the access card **58** is valid and the access reader **14** outputs formatted data to perform actions to allow the access card holder to gain access to the secured area. Security may be increased by maintaining the secrecy of the hash key and/or the CRC.

TABLE 2

Access Reader Actions for an Activated State

	Correct	Data	Valid	Access Reader Action	
	Read Key	Read	CRC	Beeps	Output
1	N	N	N	2	none
2	Y	N	N	2	none
3	Y	Y	N	2	none
4	Y	Y	Y	1	Formatted Data
5	Other	Reader	Errors	2	none

[**0044**] Referring to **FIGS. 2 and 5**, the access cards **58** of the preferred embodiment are standard production contactless smart cards formatted for use with the access control system **200**. If desired, these cards **58** can be securely shared among multiple systems, such as transit system fare-card applications, building physical access control applications, equipment access applications and loyalty applications. The memory in a standard production smart card **208** is divided into blocks. Each block **400**, as shown in **FIG. 8**, contains multiple pages of read/write memory for storage of application data **408**, and an associated page for storing a read key **404** and a write key **406**. Each block **400** is assigned an application type number (ATN) **402**, e.g., transit or access control.

[**0045**] For example, in a standard memory smart card, there are a number of available memory blocks **400**. A set of one or more blocks **400** of memory on a smart card **208** used for an application is referred to as a customer memory area (CMA). Each customer memory area can use up to the total number of blocks available on the smart card **208**. For access control applications, the customer memory area can vary from 16 bytes for simple identification to up to 32 Kbytes for intensive biometric identification since access reader **202** uses only one application type number **402**. and read key **404** from cards that it has been programmed to use. Since each customer memory area uses customer specified read and write cryptographic keys **404**, **406** to secure the card, each customer memory area is both secure and inaccessible to anyone, i.e., an access card reader, that does not have the correct cryptographic keys **404**, **406**.

[**0046**] Adding access control capabilities to an existing smart card requires at least one application block **400** to be unused and available in the smart card memory. This allows multiple applications, such as transit for subway and buses, loyalty, payment systems, identity, and/or additional physical access control applications, to be loaded seamlessly and securely onto the same contactless smart card. **FIG. 7** illustrates example applications of the access control system **200**. Each application may be connected **382** to a central computer **380**. A first application for physical access control is illustrated as a door **370** controlled by an access reader **372** having a keypad ID device **374**. An employee presents his or her access card **58** to the access reader **372** and enters a code on the keypad **374**. The code is verified with identification data **408** stored on the smart card to determine the validity of the smart card. In an alternate embodiment of the invention, other identification devices may be used in place of, or in addition to, the key pad **374**. For example, in an alternate embodiment of the invention, the access reader **372**, **352**, **360** may require more than one identification device. In such an embodiment, the smart card application data **408** contains the identification data for comparison with the data received from each identification device. The access control system may also be used to control access to equipment such as personal computers **350**. For example, an access reader **352** having an RF interface **354** for reading a smart card, and a fingerprint pad **356** for identifying the access card holder, may be used with security software installed on the personal computer **350** to limit access to the computer **350**. The smart card may also contain an application type number **402** that is utilized by access readers **360** at transit gates **358**.

[**0047**] A method for smart card access control **400** is illustrated in **FIG. 9**, with reference to system components of **FIG. 5**. In a first step **452**, the access reader **202** establishes communication with a smart card **208** configured as an access card. If communication is established successfully, then the smart card **208** has responded to a communication protocol used by the access reader **202**. In step **454**, the access reader **202** reads and stores access card application data from the access card. The access reader determines whether the access card is valid in step **456**. If the access card is invalid, step **458**, for example, parity is incorrect or the read keys used by the access reader **202** are invalid, access to the secured area is denied, step **464**.

[**0048**] The preferred embodiment of the invention provides the optional steps of recording the access card data in a log file, step **460**, and writing an invalid flag to the access card, step **462**, providing the access reader **202** knows a required write key for the access card **208**. In step **466**, the access reader **202** receives identification data from an ID device **204**, and compares the application data with the identification data, step **468**. A data match in step **470** results in the access reader **202** outputting a signal **222** to a secured device **206** to allow an access card holder access to a secured area. In optional steps **472** and **474**, the access reader **202** stores the transaction data to a log file and updates a status on the access card **208**.

[**0049**] Although a preferred embodiment of the invention has been described above by way of example only, it will be understood by those skilled in the field that modifications may be made to the disclosed embodiment without departing from the scope of the invention, which is defined by the appended claims.

We claim:

1. A system for providing controlled access to a secured area, the system comprising:

a secured device for allowing access into the secured area upon receiving at least one access control signal;

an identification device for providing identification data of an access card holder;

an access card having at least one block of memory comprising:

application data corresponding to a unique identifier of the access card holder; and

at least one application security key comprising an application read key; and

an access reader for outputting the at least one access control signal for controlling the secured device, the access reader comprising:

a memory means for storing configuration data and at least one valid security read key;

an RF interface for reading the application data from the access card if the at least one valid security read key is the same as the application read key, the at least one valid security read key providing an authenticated reading of the application data from the access card;

at least one input data line for receiving the identification data from the identification device; and

a processor means for comparing the application data to the identification data and for outputting the at least one access control signal upon a match between the application data and the identification data.

2. The system of claim 1, wherein the secured device is a transit gate.

3. The system of claim 1, wherein the secured device allows operation of electronic equipment having a device processor, further comprising:

security software for execution by the device processor, the security software disallowing use of the electronic equipment unless the at least one access control signal is received by the security software.

4. The system of claim 1, wherein the identification device is a biometric device and the identification data is image data.

5. The system of claim 4, wherein the identification data comprises template minutia comprising characteristics of the identification data.

6. The system of claim 5, wherein the processor means for comparing the application data is automated.

7. The system of claim 4, wherein the access reader further comprises means for displaying the image data and the application data, the displayed image data and application data for use by a security person for making a decision regarding issuance of the at least one access control signal for allowing access to the secured area.

8. The system of claim 1, wherein the access reader has a plurality of reader states comprising:

an activated state for controlling access to the secured area; and

a deactivated state, the deactivated state having an activation key for reading an activation card.

9. The system of claim 1, further comprising an update card for updating the configuration data of the access reader.

10. The system of claim 1, wherein the at least one application security key of the access card further comprises an application write key.

11. The system of claim 10, wherein the memory means of the access reader further stores a valid security write key for writing to the access card if the valid security write key is the same as the application write key.

12. The system of claim 11, wherein the access reader writes an invalid flag to the access card if the application data does not match the identification data.

13. A method of controlling access to a secured area using an access reader, the method comprising the steps of:

providing identification data corresponding to an access card holder to the access reader;

reading application data corresponding to the access card holder from an access card, comprising the steps of:

transmitting an application read key from the access reader to the access card; and

allowing output of the application data from the access card if the transmitted application read key matches a read key stored on the access card;

comparing the application data to the identification data; and

outputting at least one access control signal upon a match between the identification data and the application data, the at least one access control signal for allowing access to the secured area.

14. The method of claim 13, wherein the at least one access control signal opens a gated entrance.

15. The method of claim 13, wherein the at least one access control signal allows the use of a processor enable device.

16. The method of claim 13, wherein the step of providing identification data corresponding to an access card holder to the access reader comprises the step of:

producing an image of the access card holder, wherein the image is one of a facial image, a retinal image, and a fingerprint image.

17. The method of claim 13, wherein the step of comparing the application data to the identification data is performed by the access reader.

18. The method of claim 13, wherein the step of comparing the application data to the identification data is performed by a security person.

19. The method of claim 13, further comprising the step of:

writing an invalid flag to the access card upon a mismatch between the identification data and the application data, the invalid flag for at least partially restricting use of the access card.

20. The method of claim 13, further comprising the step of updating configuration data of the access reader using a contactless update card.

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